Mathematical Modeling of Metal Forming Processes

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Abstract. Mathematical model uses nonlinear correlations of deformable bodyes. The surface of the workpiece reaches the boundary of matrix then It slides along them with friction. Elastic unloading determines the shape of the part after removal of the load. Implementation of solution is carried out by method of finite elements. Examples of solving two-dimensional problems are given.

Keywords: deformation, matrix, elasto-plastic, method of finite elements, friction, spring back.

1. Introduction

When processing metals by pressure the blanks are subjected to various external influences and experience great elasto-plastic deformation when the parts are made of them [1]. Deformation in many real processes takes place in spaces bounded by relatively rigid matrices and (or) punches. In this mathematical model describing such processes, the following dependencies:

- there are nonlinear geometric relation between the logarithmic strain tensor Hencky and the gradient of the displacement vector;
- the balance equation of mass and energy are leading to dependency of the divergence of the Cauchy stress tensor and to boundary conditions for this tensor [2];
- physical relations between the tensors Cauchy and Hencky are satisfying the principles of material objectivity, determinism and indifferentist [3];
- the region of elastic deformations is separated from the region of plastic deformations by a loading surface with translational and isotropic hardening. In the examples, this surface is represented in the form of Mises relations;
- the kinematic boundary conditions for the normal component of the displacement vector and mixed (static and kinematic) conditions are used to describe the behavior of the workpiece surface in the area of its contact with the mat (punch).
- the conditions consider the motion with friction of the contacting surfaces for the tangential component.

The decision task is carried out by finite element method. The solutions implemented using the method of successive loading with an inner iterative cycle. At each loading step is reconstruction of the of the geometry of the workpiece and the configuration of finite elements.

After the end of the deformation process (output all boundary points the workpiece to the surface of the matrix) external influence “reset” and on the elastic law is in the process of spring. The difference between the obtained shape of the surface details and the surface shape of the matrix allows to adjust

the shape of the matrix so that after the completion of the forming process and spring turned item desired configuration.

Examples of solving problems of metal forming of axisymmetric bodies under free deformation in the space defined by the punch. The shape of the part after removal of the load and spring was determined.

2. References

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